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ABSTRACT

An experiment was performed in a two semester introductory college physics course for non-science majors. The goal of the experiment was to determine the extent to which computer-assisted instruction (CAI) and knowledge of group dynamics can overcome the serious instructional problems of large introductory lecture courses. Students were divided into three sections. Students in one section received the CAI as individual students; students in another section studied in small groups and received the CAI as a group; the third section served as a control group. Academic achievement, attitudinal development, and the sociometry of the students in the test sections were studied. It was found that the students preferred small group instruction. The students studying in small groups sometimes achieved academic results which were superior to the control group; but occasionally the small group produced significantly inferior results. When this happened, the group also demonstrated a significant deterioration in social structure. The small group instruction had a much lower cost per pupil than did the individual use of CAI. It was therefore concluded that a combination of CAI and careful attention to group dynamics may be an effective and economical way to solve the problem of large group instruction in introductory college courses. (JY)

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COMPUTER ASSISTED INSTRUCTION OF COLLEGE PHYSICS STUDENTS IN SMALL GROUPS

August 1972

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ABSTRACT

A combination of computer assisted instruction, CAI, and group process has been used to produce an effective and efficient instructional technique. The technique was developed in order to improve the effectiveness of the instruction in large lecture classes in which beginning college students are most likely to be enrolled. The form of CAI used was computer delivery of responses especially prepared for the answers to multiple choice homework questions.

Each of three test classes was divided into three test sections. Students in one section received the CAI as individual students. Students in another section studied in small groups and received the CAI as a group. The third section was the control group. Academic achievement, attitudinal development and the sociometry of students in the test sections were studied.

Students studying in the small groups often achieve academic results which are superior to the control group. Occasionally, perhaps due to faulty group constituency, the small groups produce inferior results.

The combination of CAI and group process can indeed be effective. However, care should be exercised in constituting the groups to avoid negative sociological effects which sometimes occur in group interactions.

Final Report

Project No. 1F072
Contract No. OEC-6-71-0517-(509)

Computer Assisted Instruction of College Physics Students in Small Groups

Glen E. Terrell

The University of Texas at Arlington

Arlington, Texas

August 1, 1972

The research reported herein was performed pursuant to a contract with the Office of Education, U. S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgement in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

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PREFACE

Significant progress and program development have been achieved during the past 15 months which will surely have a long term effect within The University of Texas at Arlington Physics Department. The computer programs and educational software which have been produced will continue to be beneficial as the developed technique is implemented in the departmental instructional program. It is very unlikely that this work could have been done without the support of the U.S. Office of Education for which we are very grateful.

The considerable energy and leadership generally provided by graduate students was not available to this project. Therefore, an especially grateful thank you is due a small but effective group of undergraduates and one high school student. Mr. Carl Cheney, a high school student, produced all the computer programs in the CAI project. Significant contributions were made by undergraduates Miss Diana Nelson, Mr. Mike Maurer, Mr. Mike Parker and especially Mr. Richard Taylor, a student of physics and future science teacher.

The kind words, insight and hard work of two associates and exemplary teachers Dr. William B. Self and Dr. Mary Lynn Crow are also gratefully acknowledged.

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Chapter I - INTRODUCTION

The experiment, the results of which are reported herein, was performed in a two semester introductory college physics course for nonscience majors. The classes met for two one-hour lectures and one two-hour laboratory each week. Three semester credit hours are earned for each semester's work. The course is not specifically required, but can be used to satisfy specific science course requirements. Most students in the course have majors in the Schools of Liberal Arts or Business Administration. These students must satisfy a 6 or 12 semester credit hour requirement in the laboratory sciences depending on their particular major.

The problem to which this research effort was addressed is the generally ineffective instruction of large college lecture classes. For the past several decades, the number of students per class in introductory college courses has continually increased so that today, freshman classes of several hundred students are common. However, in general, teaching techniques have not changed to overcome the educational problems which result from large class size.

About 2-1/2 years ago, an experiment utilizing both group dynamics and computer assisted instruction, CAI, was initiated in an effort to develop a teaching technique which would overcome the more serious instructional problems of the large lecture class. The goal of the project was to provide the student in a large class an opportunity for academic achievement and personal development at least equivalent to his counterpart in a small class in which conventional instructional techniques are used.

The more significant parts of the thesis upon which this experiment was initiated are

(1) strong person-to-person interaction between fellow students will produce some of the positive effects usually hoped for through student-faculty interaction, but unattainable in the very large class,

(2) CAI administered to students in small groups is a very effective teaching technique, and is probably more effective than CAI administered to individuals, and

(3) the union of CAI and small group dynamics will create a productive learning environment highly conducive to positive attitude development and positive attitude change.

The primary objective of the reported activities was to compare the effectiveness of CAI administered to individual students with the effectiveness of the same computer based materials administered to small

groups of students studying together. The achievement of students studying in each of these modes was also compared with the achievement of students in a control group.

Numerous studies have shown that group process is beneficial to learning in other learning environments. Therefore, it was believed that under the proper circumstances, group process would enhance the effectiveness of CAI. If such a program could be developed, the number of computer terminals and the amount of computer time required to effectively serve students could be reduced. If the average group had nine students, the cost of implementing the program could be reduced by a factor of 9, a substantial contribution.

The criteria for success of the program are academic achievement, attitudinal development and the social development of the individual student. Although certain precautions must be exercised, the results of this experiment indicate that computer assisted instruction of students in small groups can produce superior academic results, very favorable attitudinal and social development of the individual and accomplish this within a large lecture class.

Chapter II - PROCEDURES

Students within each test class were divided into three subclasses. The data used to achieve "equal" subclasses was obtained by a questionnaire administered during the first few minutes of the first class meeting. (See GROUP ESTABLISHMENT-FORM A, FORM B for the Spring term, in Appendix A.) The criteria used to produce equal subclasses were to what extent the student desired to participate in the experiment, sex, and to a lesser extent math background, age and marital status. Each subclass contained equal numbers of students who wanted to participate in the CAI experiment, equal numbers of students who did not want to participate in the CAI experiment and approximately equal numbers of males and females.

The three subclasses met in the same classroom at the same time and received the same lectures from the same professor. They received the same homework, major exams, final exam and their semester grades were computed using the same formula. The primary difference in the treatment of students within each subclass was the activities involving periodic (weekly, except for testing intervals) homework assignments.

Prior to the beginning of each semester some 100 multiple choice question units were prepared to be used in homework exercises. Each unit consisted of

(1) a statement of the problem or question,
(2) three to five possible answers, and
(3) an analysis of each available answer.

As often as possible, the problems or questions represented applications of physics to the common experience of the layman. In many cases, the problem situations contained an element of appropriate humor. The available answers corresponded to common arithmetic errors and common misconceptions of science. The analysis of (or response to) each incorrect answer explained what error had probably been made in obtaining that answer and what the correct answer was. The analysis of (or response to) the correct answer generally provided some reinforcement material in the form of additional physical situations to which the problem applies and/or an additional question for thought. All the units were typed into the computer via the remote typewriter-like computer terminal of the Physics Department and stored on magnetic discs. Computer programs were written to separate the question and answers from the answer responses and for other information processing.

Each week, except when examinations were administered, a homework assignment was made up from the available problems and a duplicating master was typed by the computer via the terminal. A typical assignment is shown in Appendix B. Each assignment contained between six and twelve question units depending on the difficulty of each unit and the amount of new material covered since the previous assignment.

For each test class, the students within the three subclasses received the homework assignments at the same time and their work was due at the same time one week later. The students' answers to the multiple choice questions were written on small answer sheets which were provided (see Appendix B). The answers of the individual students were typed into the computer via the terminal. Appropriate computer programs had been prepared to accept and grade the answers of the students in the three subclasses. The student answers and grades were then stored within the computer for later use.

The three subclasses were appropriately called CONTROL subclass, INDIVIDUAL subclass and GROUPER subclass.

For students within the CONTROL subclass the computer program simply graded their work and printed a weekly report as shown in Figure 1. In the column headed TODAY the students' grades on the most recent homework assignment were given. The lowest of the accumulated homework grades was ignored and the average of the remaining grades was calculated and printed in the column headed AJ.AV. (This is the manner in which homework grades were to be treated in determining the students' semester grades.) Under the column ANSWERS the program printed the answers which had been typed into the computer for each student. The incorrect answers were printed in upper case characters. If a student did not turn in an assignment the appropriate number of *'s appeared in this column. This report was available to project staff immediately after the student answers were put into the computer, and was posted on a bulletin board usually the same day the homework was due. Students in the CONTROL subclass were encouraged to examine the report to determine how well they had done and which specific problems they had missed.

The students within the INDIVIDUAL subclass went to the computer terminal at a scheduled time after the homework was due but before the next class meeting. The time schedule was such that only one student should be in the terminal room at a time. The student established communications with the computer using a printed list of simple instructions. (See AS AN INDIVIDUAL..., Appendix C.) The student identified himself by the last four digits of his social security number and immediately gained access to a suspended computer program. The program examined the student's answers to the homework questions (already entered by project staff) and selected the appropriate previously written responses (analyses). The INDIVIDUAL student received the programmed responses to his answers via the typewriter-like computer terminal. While receiving the computer output the student had the option of asking for the programmed response for any answer on each homework question. When the computer responses was complete the student received a report of his individual progress, equivalent to the report in Figure 1 for each student.

WEEKLY REPORT OF HOMEWORK ACHIEVEMENT OF STUDENTS

IN THE CONTROL SUBCLASS

NAME	TODAY	AJ.AV.	ANSWERS
Robert A.	83.33	79.77	BdcabbbcdbbE
Walter B.	100.00	90.00	edcabbbcdbbc
Rea B.	100.00	85.11	edcabbbcdbbc
James C.	100.00	92.00	edcabbbcdbbc
Mary C.	91.66	89.44	edcabbbcBbbc
Stephen E.	83.33	88.66	CdcabbbcBbbc
Chris F.	91.66	92.33	edcabbbcBbbc
Darwin F.	91.66	83.44	edcabbbcBbbc
Vicki F.	83.33	88.66	CdcabbbcBbbc
William F.	83.33	88.66	CdcabbbcBbbc
David F.	83.33	87.77	CdcabbbcBbbc
Allen G.	83.33	87.80	edcaAbbcBbbc
Ruth G.	83.33	89.99	DdcabbbcBbbc
Gary H.	83.33	92.22	BdcabbbcdbbE
Bobby H.	.00	50.88	**********
Keith K.	83.33	85.14	BdcabbbcBbbc
Michael K.	83.33	89.99	BdcabbbcBbbc
Fulgencio	83.33	78.95	CdcabbbcBbbc
Christophe	75.00	91.00	BdcabbbcBbDc
Navid H.	.00	33.28	**********
James H.	.00	91.55	**********
Jacky P.	66.66	77.61	BdcaDDbcBbbc
Gary P.	91.66	76.17	edcaAbbcdbbc
Dwaine R.	75.00	76.33	BdcaDbbcBbbc
Henry R.	100.00	99.77	edcabbbcdbbc
David S.	91.66	93.66	edcabbbcBbbc
Charles S.	75.00	76.33	edcaCbbDBbbc
Leslie W.	83.33	78.95	BdcabbbcBbbc
Blaine W.	83.33	81.77	BdcabbbcBbbc
Brooks, E.	.00	2.00	**********

Figure 1

Students within the GROUPER subclass were further divided into small groups, typically 7 or 8 students per group. Each small group of students met at a scheduled time to reconsider the homework problems. Coffee was provided and the students were encouraged to enjoy their group meetings.

The group chairmanship was to rotate among the group membership until every member had served as "group leader" at least one time. The group was provided an agenda (see Appendix C) which they were to follow for each group meeting. They were to socialize for a minimum of 10 minutes before considering the homework. The group was to consider each question in turn. Every group member was to comment to some extent on each question and to seek some consensus on each question. After consideration of the problems the group then established communications with a suspended computer program via a series of written instructions. (See AS A GROUP..., Appendix C.) The program checked roll (for group meeting attendance) and then asked for the group answers to the homework. A member of the group typed in the group's answers and the computer then responded to the group's answers as it had to the INDIVIDUALs. Again students in the group had the opportunity to obtain the response for any other answers to the homework questions. When the computer response was complete the group received a report on how well the group and the group members had done. An actual group report is shown in Figure 2. The first part of the report is similar to that for the CONTROL subclass. The last portion of the report indicated how well the group performed, what the results would have been if those members present had simply voted, the result of a "vote" of all group members, the average performance of those group members present and finally the average performance of the entire group membership. It was anticipated that the "group" would be equal to or better than the "pres. vote" which should in turn be better than the "pres. avg.".

It was estimated that the CAI activities would require about 15 minutes per week for students in the INDIVIDUAL subclass and 45 minutes per week for students in the GROUPER subclass. It was considered essential to equalize the amount of time required by the course for all students independent of their respective subclass. Therefore, the number of laboratory sessions attended by students in the INDIVIDUAL and GROUPER subclasses was reduced by 2 and 4 respectively.

The same experimental procedure was used in three test classes. Test Class 1 was a regular day class with an initial enrollment in the Fall 1971 term of 99 students. It was taught by the project director. Test Class 2 was another regular day class with an initial enrollment in the Fall 1971 term of 113 students. Test Class 3 was an evening course with an initial enrollment of 34 students. Test Classes 2 and 3 were taught by Dr. William B. Self.

WEEKLY REPORT OF GROUP HOMEWORK ACHIEVEMENT

NAME	TODAY	AJ.AV.	ANSWERS
Michael C.	77.77	100.00	BBdhbahdc
Glenn D.	77.77	83.88	aCdhbaCdc
Stephen E.	55.55	90.00	BBdhbaDdB
Jebbie E.	77.77	95.00	aCdhbahBc
George F.	77.77	95.00	BEdbhahdc
Robert H.	33.33	80.00	BDdhCBDdD
Paula H.	77.77	95.00	BBdhbahdc
Linda S.	66.66	95.00	BCdhbahBc
group	100.00	100.00	aadhbahdc
pres. vote	88.88	100.00	aAdhbahdc
tot. vote	88.88	100.00	acdhbahdc
pres. avg.	73.00	85.71	
total avg.	68.04	80.62	

Figure 2

If significantly different results were observed for the separate subclasses within a given test class, it would be important to know how "equal" the subclasses really were originally. In order to obtain a measure of the equality of the subclasses the average of several variables were studied. (A comparison of several averages is shown in TABLE 1.) Of course all this information was not available at the time the subclass divisions were made.

The experimental procedure and the nature of the three test classes were the same in each of the two semesters. A few students were registered in the course in the Spring who had not been in the course during the Fall. These were music majors who had taken a physics course designed especially for music majors during the Fall term. There were only 37 such students and their presence for only one semester probably did not affect the experimental results. Some students changed from one instructor to the other for the second semester but this probably did not affect the experimental results either.

A sociometric study was made in each of the test classes. Each student in the class was to indicate how strongly he or she would like to work with and simply chat with every other member of the class. The actual instrument used is in Appendix A. The instrument was administered on the third class meeting and during the last week of class of each semester. Results of the two surveys were studied to determine the social structure of the class and to determine changes in social structure during the semester.

The Rokeach Attitude Scale instrument (see Appendix A) was administered once during the Fall Semester and once during the Spring Semester. Only students who had not taken the test during the Fall term took the test during the Spring term. The analysis of the results of the Rokeach instrument was used in reviewing the equality of the subclasses (see TABLE 1). If any of the small groups failed to meet expectations, the distribution of Rokeach scores among the group members might be useful in understanding why the group failed. It is interesting to note that the average result on the Rokeach instrument for all the students participating in this experiment was 140 $\pm$ 28 and the average result for all American college students is 141 $\pm$ 28.

Two different instruments were used to determine the students' attitude toward physics as a subject and toward the professor who was teaching the course. One instrument (see Attitude Determination - Form A, Appendix A) was used to determine the students' initial attitude. This instrument was administered at the beginning of the first class meeting each semester. The other instrument (see, Attitude Determination - Form B, Appendix A) was administered about midway through each semester and again at the end of each semester.

TABLE 1

EQUALITY OF EXPERIMENTAL TEST GROUPS

			Number of Students	Number of Males	Number of Females	GPR* All College (A=3.0)	Rokeach Attitude Scale**
Fall, 1971 Semester	TEST CLASS 1a	CONTROL	30	26	4	1.64	144.9 ±24.8
		INDIVIDUAL	28	23	5	1.46	141.2 ±27.4
		GROUPER	23	18	5	1.43	129.6 ±13.6
	TEST CLASS 2a	CONTROL	38	28	10	1.56	142.9 ±28.4
		INDIVIDUAL	31	24	7	1.61	137.5 ±29.6
		GROUPER	36	27	9	1.62	146.3 ±28.7
	TEST CLASS 3a	CONTROL	10	9	1	1.55	137.7 ±41.3
		INDIVIDUAL	9	8	1	1.30	146.4 ±15.9
		GROUPER	10	8	2	1.90	145.3 ±21.5
Spring, 1972 Semester	TEST CLASS 1b	CONTROL	26	22	4	1.70	144.0 ±24.4
		INDIVIDUAL	25	19	6	1.54	147.2 ±19.7
		GROUPER	22	16	6	1.48	131.7 ±20.8
	TEST CLASS 2b	CONTROL	36	28	8	1.70	138.2 ±30.0
		INDIVIDUAL	28	23	5	1.62	149.3 ±31.9
		GROUPER	36	29	7	1.77	136.8 ±34.5
	TEST CLASS 3b	CONTROL	9	8	1	1.94	127.0 ±37.1
		INDIVIDUAL	7	6	1	1.66	129.4 ±25.6
		GROUPER	7	5	2	1.72	146.4 ±11.6

*The GPR (grade point ratio) figures include all the student's college work completed at UTA through the Fall, 1971 semester. In the UTA system, an A is equivalent to 3 grade points per semester hour.

**The uncertainties are standard deviations.

Chapter III - RESULTS

Attitude

In determining the students' attitude toward course and instructor, each student had to select one of 5 choices available (see Appendix A for the questionnaire used):
A. very positive, B. positive, C. Neutral, D. negative, E. very negative.

The students' attitude toward both course and instructor was investigated three times each semester in Test Classes 1 and 2. The results are shown in TABLES 2 and 3. Polls 1, 2, and 3 correspond to the beginning, middle and end of the semester respectively. In constructing the table a student's attitude was considered positive if he responded with A or B, and negative if he responded either D or E.

The development of the attitude of students in the GROUPER subclass seems to be more favorable and less fragile. In Test Class 1a, the students did not particularly appreciate the material which was being considered toward the end of the semester. After the semester was over several students commented that most of the class had already considered the material in their precollege studies. As a result, the attitude toward the course of the CONTROL and INDIVIDUAL subclasses regressed. However, the attitude of the GROUPER subclass continued to improve.

There is no apparent correlation between student attitude toward course and toward instructor. In Test Class 1a, even when the attitude toward the course of students within the CONTROL subclass regressed, their attitude toward the instructor continued to improve. The same was true of students in the INDIVIDUAL subclass.

Most of the change in attitude occurs before the middle of the first semester. Thus the beginning of the semester is very important in the development of students' attitudes, particularly toward subject matter. One may notice that in the Fall the change in attitude is greater than during the Spring. However, the attitude of the students as a whole was much more positive at the beginning of the Spring term than at the beginning of the Fall term so there was less opportunity for positive change.

If one considers the sume of entries along the "neg." column for each subclass in TABLES 2 and 3, then it seems that students in the CONTROL subclass are about 50% more likely to have a negative attitude toward the course and 400% more likely to have a negative attitude toward the instructor as students in either of the CAI subclasses.

TABLE 2

STUDENT ATTITUDE TOWARD COURSE

(entries in percent)

			CONTROL			INDIVIDUALS			GROUPER		
			pos.	neut.	neg.	pos.	neut.	neg.	pos.	neut.	neg.
Fall '71 Semester	TEST CLASS 1a	Poll 1	68	31	0	60	40	0	53	46	0
		Poll 2	84	0	15	90	5	5	78	8	15
		Poll 3	69	15	16	35	60	5	84	0	15
	TEST CLASS 2a	Poll 1	79	19	5	78	22	0	62	38	0
		Poll 2	86	14	0	94	0	5	87	13	0
		Poll 3	100	0	0	100	0	0	100	0	0
Spring '72 Semester	TEST CLASS 1b	Poll 1	100	0	0	77	23	0	94	6	0
		Poll 2	76	5	10	86	14	0	87	6	6
		Poll 3	90	10	0	91	0	9	94	6	0
	TEST CLASS 2b	Poll 1	86	14	0	93	7	0	84	16	0
		Poll 2	79	14	7	83	10	7	80	12	8
		Poll 3	79	14	7	83	7	10	84	16	0

TABLE 3

STUDENT ATTITUDE TOWARD INSTRUCTOR

(entries in percent)

			CONTROL			INDIVIDUALS			GROUPER		
			pos.	neut.	neg.	pos.	neut.	neg.	pos.	neut.	neg.
Fall '71 Semester	TEST CLASS 1a	Poll 1	15	85	0	5	95	0	39	62	0
		Poll 2	72	15	8	50	40	10	76	15	7
		Poll 3	84	8	8	55	45	0	77	23	0
	TEST CLASS 2a	Poll 1	24	76	0	11	89	0	18	81	0
		Poll 2	86	10	5	100	0	0	100	0	0
		Poll 3	95	5	0	100	0	0	100	0	0
Spring '72 Semester	TEST CLASS 1b	Poll 1	81	19	0	73	27	0	69	31	0
		Poll 2	90	5	5	95	5	0	100	0	0
		Poll 3	85	15	0	95	5	0	100	0	0
	TEST CLASS 2b	Poll 1	64	29	7	80	20	0	92	8	0
		Poll 2	86	11	4	90	7	3	92	8	0
		Poll 3	89	4	7	90	10	0	100	0	0

At the end of the experiment, the students were asked to write a paragraph or two describing their personal evaluation of the experiment. A copy of the actual assignment given in Text Classes 2 and 3 is given in Appendix A. Several of the students were members of two different subclasses (CONTROL, INDIVIDUAL and GROUPER) in the two semesters of the experiment. Almost all those students who had been a GROUPER preferred it to either of the other two. However, a few architecture students indicated that they preferred the INDIVIDUAL mode of instruction to the GROUPER mode. All those students who had been in the CONTROL subclass one semester and one of the CAI subclasses the other semester, expressed a preference for the CAI mode of instruction.

Academic

A study was made of the distribution of semester grades earned by students in each test class. The results of this study are shown in TABLE 4 (Fall Semester) and in TABLE 5 (Spring Semester). The distributions shown are for each subclass (CONTROL, INDIVIDUAL, GROUPER) and for each of the small groups within the GROUPER subclass. The column label GPR is the grade point ratio (number of grade points per semester credit hour divided by the number of students) for grade points earned in the physics class only. In the UT Arlington system the grade of A is equivalent to 3.0 grade points per credit hour.

The uncertainties expressed in the GPR column are not mathematical uncertainties, but represent the extremities of a possible range of GPR figures. The negative "uncertainties" were obtained by computing the GPRs which result if the minimum semester average required for an A, B and C were 90, 80 and 70 respectively. The positive "uncertainties" were obtained by computing the GPRs which result if the minimum semester average required for an A, B, C, etc. were as low as good conscience would allow. A difference between GPR figures of 0.1 is believed to be insignificant, a difference of 0.2 perhaps significant and a difference of 0.3 certainly significant. Thus for test class 3a in the Fall Semester (TABLE 4) one can say with some certainty that the average achievement of the GROUPER subclass was superior to the CONTROL subclass, and that there was probably no significant difference in the achievement of the INDIVIDUAL and CONTROL SUBCLASS.

The GPR figures are displayed graphically in Figure 3. The results for the Fall Semester (Test Classes 1a, 2a and 3a) are not conclusive. One group in Test Class 1 and one group in Test Class 2 seem to have done somewhat worse than the CONTROL subclass or the INDIVIDUAL subclass. In Test Class 1a, groups 3 and 4 did not adhere to the agenda, and spent considerably less time in the group meetings than they were asked to. For the night students (Test Class 3a) the one group seems to have done better than either of the other two subclasses.

The results for the Spring Semester are somewhat more interesting. In Test Class 1b, one group did better, one about the same and one worse than the CONTROL subclass. Analysis of the sociometric study shows that there was significant deterioration of the social structure of the one group which was an academic failure (see subsection on sociometric study).

TABLE 4

ACADEMIC RESULTS FALL SEMESTER

(all entries in percent)

		A's	B's	C's	D's	F's	GPR* Physics Only (A=3.0)
TEST CLASS 1a	CONTROL	23	37	37	3	0	$1.8^{+.3}_{-.1}$
	INDIVIDUAL	25	46	29	0	0	$2.0^{+.4}_{-.2}$
	GROUPER	17	30	52	0	0	$1.6^{+.3}_{-.2}$
	Group 1	20	40	40	0	0	$1.8^{+.2}_{-.0}$
	Group 2	33	33	33	0	0	$2.0^{+.2}_{-.2}$
	Group 3	17	33	50	0	0	$1.7^{+.0}_{-.7}$
	Group 4	0	17	83	0	0	$1.2^{+.5}_{-.2}$
TEST CLASS 2a	CONTROL	32	38	22	10	0	$1.9^{+.2}_{-.1}$
	INDIVIDUAL	26	55	16	3	0	$2.0^{+.2}_{-.2}$
	GROUPER	25	39	30	8	0	$1.8^{+.3}_{-.1}$
	Group 1	44	22	22	11	0	$2.0^{+.1}_{-.2}$
	Group 2	33	44	11	11	0	$2.0^{+.0}_{-.1}$
	Group 3	0	33	66	0	0	$1.3^{+.7}_{-.1}$
	Group 4	22	55	11	11	0	$1.9^{+.2}_{-.1}$
TEST CLASS 3a	CONTROL	30	60	10	0	0	$2.2^{+.3}_{-.0}$
	INDIVIDUAL	33	44	22	0	0	$2.1^{+.1}_{-.0}$
	GROUPER	60	30	10	0	0	$2.5^{+.1}_{-.1}$

*The GPR (grade point ratio) figures include grade points earned in the physics class only. An A is equivalent to 3 grade points per semester credit hour.

TABLE 5

ACADEMIC RESULTS SPRING SEMESTER

(all entries in percent)

		A's	B's	C's	D's	F's	GPR* Physics Only (A=3.0)
TEST CLASS 1b	CONTROL	27	46	23	4	0	2.0 $^{+.2}_{-.4}$
	INDIVIDUAL	20	52	24	4	0	1.9 $^{+.4}_{-.2}$
	GROUPER	18	55	27	0	0	1.9 $^{+.3}_{-.1}$
	Group 1	33	66	0	0	0	2.3 $^{+.4}_{-.1}$
	Group 2	12	62	25	0	0	1.9 $^{+.2}_{-.0}$
	Group 3	12	37	50	0	0	1.6 $^{+.3}_{-.1}$
TEST CLASS 2b	CONTROL	37	31	20	11	0	1.9 $^{+.2}_{-.1}$
	INDIVIDUAL	32	52	13	3	0	2.1 $^{+.1}_{-.0}$
	GROUPER	50	42	6	3	0	2.4 $^{+.1}_{-.2}$
	Group 1	50	50	0	0	0	2.5 $^{+.1}_{-.0}$
	Group 2	55	45	0	0	0	2.6 $^{+.0}_{-.2}$
	Group 3	62	38	0	0	0	2.6 $^{+.2}_{-.2}$
	Group 4	33	33	22	11	0	1.9 $^{+.4}_{-.3}$
TEST CLASS 3b	CONTROL	33	44	22	0	0	2.1 $^{+.2}_{-.1}$
	INDIVIDUAL	29	43	14	14	0	1.9 $^{+.0}_{-.2}$
	GROUPER	71	14	0	14	0	2.4 $^{+.2}_{-.0}$

*The GPR (grade point ratio) figures include grade points earned in the physics class only. An A is equivalent to 3 grade points per semester credit hour.

GRADE POINT RATIO EARNED

IN TEST PHYSICS CLASSES

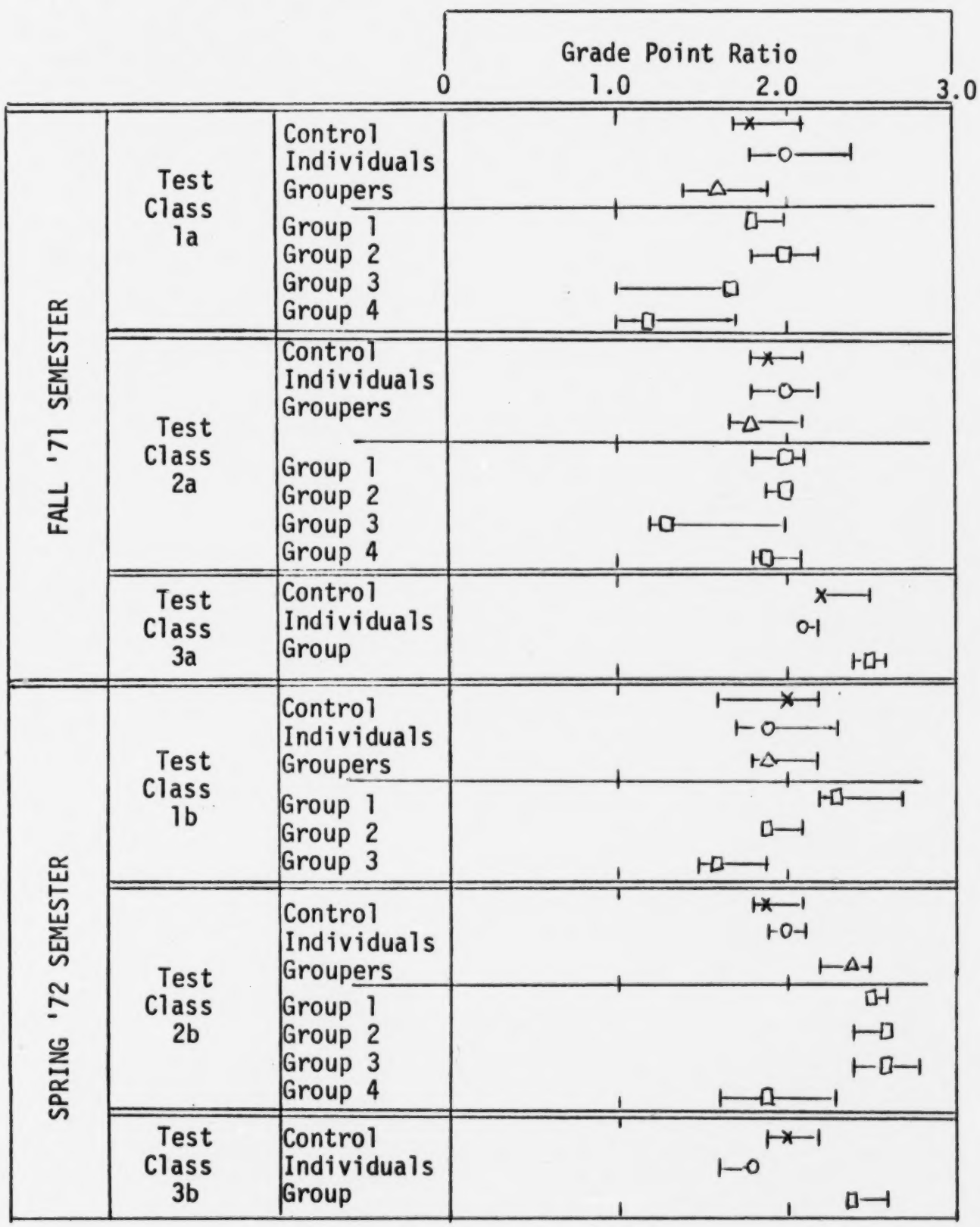

Figure 3

In Test Class 2b, the achievement of 3 of the 4 groups was significantly better than either of the other two subclasses. Analysis of the sociometric data for the least successful group indicates that the group members were less compatible at the end of the semester than at the beginning.

Some interesting comparisons can be made between the achievement for Test Class 2a and 2b. Group 2 from Test Class 2a was kept intact and became group 1 in Test Class 2b. The GPR of this group improved from 2.0 in the Fall to 2.5 in the Spring. Students in groups 2 and 3 in Test Class 2b (Spring) had been in the INDIVIDUAL subclass in Test Class 2a. These comparisons suggest that the value of the group process improved with time and that the group process considerably enhances the value of the CAI.

Similar results were observed within Test Class 3. The INDIVIDUALS from the Fall term (Test Class 3a) became the GROUP for the Spring term (test Class 3b) and vice-versa. The GPR of one set of students improved from 2.1 to 2.4 with the addition of group process and the GPR of the other set of students regressed from 2.5 to 1.9 when the group process was removed.

Another type comparison can be made of the relative success of students studying in the three different modes.

One would expect that students with high overall grade point averages would do well in physics and students who do poorly overall are likely to do poorly in physics. If this is true then mathematically there should be a strong linear correlation between the students' semester averages in physics and their overall grade point ratios, GPRs. Consequently a plot of the semester averages in physics vs overall GPR could be "fit" well with a straight line. If students studying in different modes experienced significantly different success in physics, the parameters of this straight line fit (slope and intercept) should be significantly different.

For purposes of this study the three test classes in the Fall semester were considered one test population, i.e., the three CONTROL sublclasses were considered one and likewise for the INDIVIDUAL and GROUPER subclasses. The data for the Spring term was treated in the same way.

For both the Fall and the Spring test populations it was determined that within each subclass there is indeed a strong mathemamatical correlation[+] between the students' semester averages in physics and their overall GPR. The data for each subclass was "fit" with a least-squares fitting routine and the slope and intercept of the "best" straight line fit were obtained.

[+]Correlation coefficients between .46 and .72 were obtained for sample populations between 60 and 78.

The results indicate no significant difference between the achievement of students studying in the three different modes during the Fall term. However, significant differences were noted for the Spring term.

The results of the analysis for the Spring semester is shown in TABLE 6 and the three "best fits" are plotted in Fig. 4. It is clear that the achievement of the "better" students (high GPR) does not depend much on which mode of study the student was engaged in. However, for the "poorer" student (low GPR) the results were as expected: CAI is beneficial and the group activities enhance the value of CAI. Note that for a C student (GPR=1.0), on the average, students studying in small groups with the CAI will attain a semester average about 6.5 points higher than a student exposed to conventional instructional techniques. This 6.5 points represents more than half a letter grade improvement. For students with GPRs < 1.0 (on scholastic probation at UT Arlington) the difference can approach a full letter grade.

At UT Arlington approximately 80% of the students have GPRs less than 2.0 and 9% have GPRs less than 1.0. Therefore, the combination of group process and CAI would seem to offer some much needed relief for the masses without detrimentally affecting the academic achievement of the "better" students.

Sociometry

In the sociometric study each student indicated how much he would like to work with and to visit with each of his classmates. The student had 5 choices; -2, -1, 0, +1, +2 (see Appendix A). Minus 2 is a very negative response, plus 2 a very positive response and zero, the neutral response. All the data was analyzed with computer programs which were prepared by the UT Arlington Computer Center staff.

Two different types of analysis were done. One simply determined the frequency of each type response, i.e., how many -2's +1's, etc. The other analysis determined the number of each type interaction pair, i.e., how many pairs of students responded (0,0), (0,1), etc. toward each other. The computer program allows the user to select any subset of students within each class according to any or all of the following criteria: subclass, which small group (if any), sex, academic classification and course grade. The analysis of the sociometric study was by far the most time consuming portion of the data analysis.

The sociograms for Test Class 1 at the beginning of the Fall semester is shown in Figure 5. Note that there is very little difference between the subclasses on either the work or chat sociograms. This is further evidence that the subclasses were indeed equal at the beginning of the experiment. There is also (perhaps unsurprisingly) very little difference between the work and chat sociograms. The sociograms for the other test classes were very similar.

TABLE 6

RELATIVE ACADEMIC SUCCESS OF SUBCLASSES

(Spring Semester)

Subclass	Number of Students in Population	Correlation Coefficient	Slope of Line*	Intercept of Line*
CONTROL	71	.575	9.9 ± 1.6	65 ± 3
INDIVIDUAL	60	.516	7.1 ± 1.5	72 ± 2
GROUPER	64	.458	6.4 ± 1.6	75 ± 3

*The uncertainties are standard deviations.

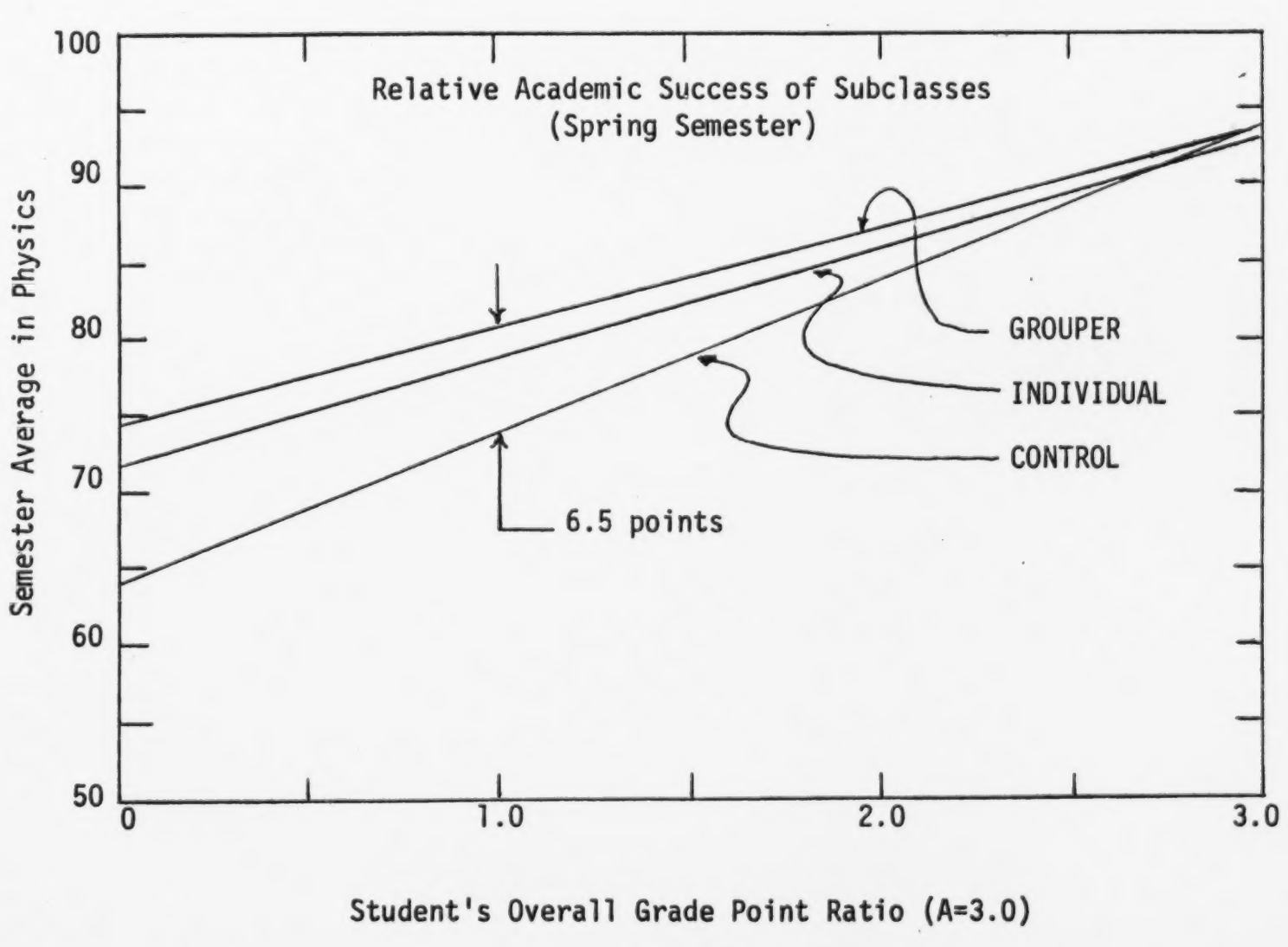

Figure 4

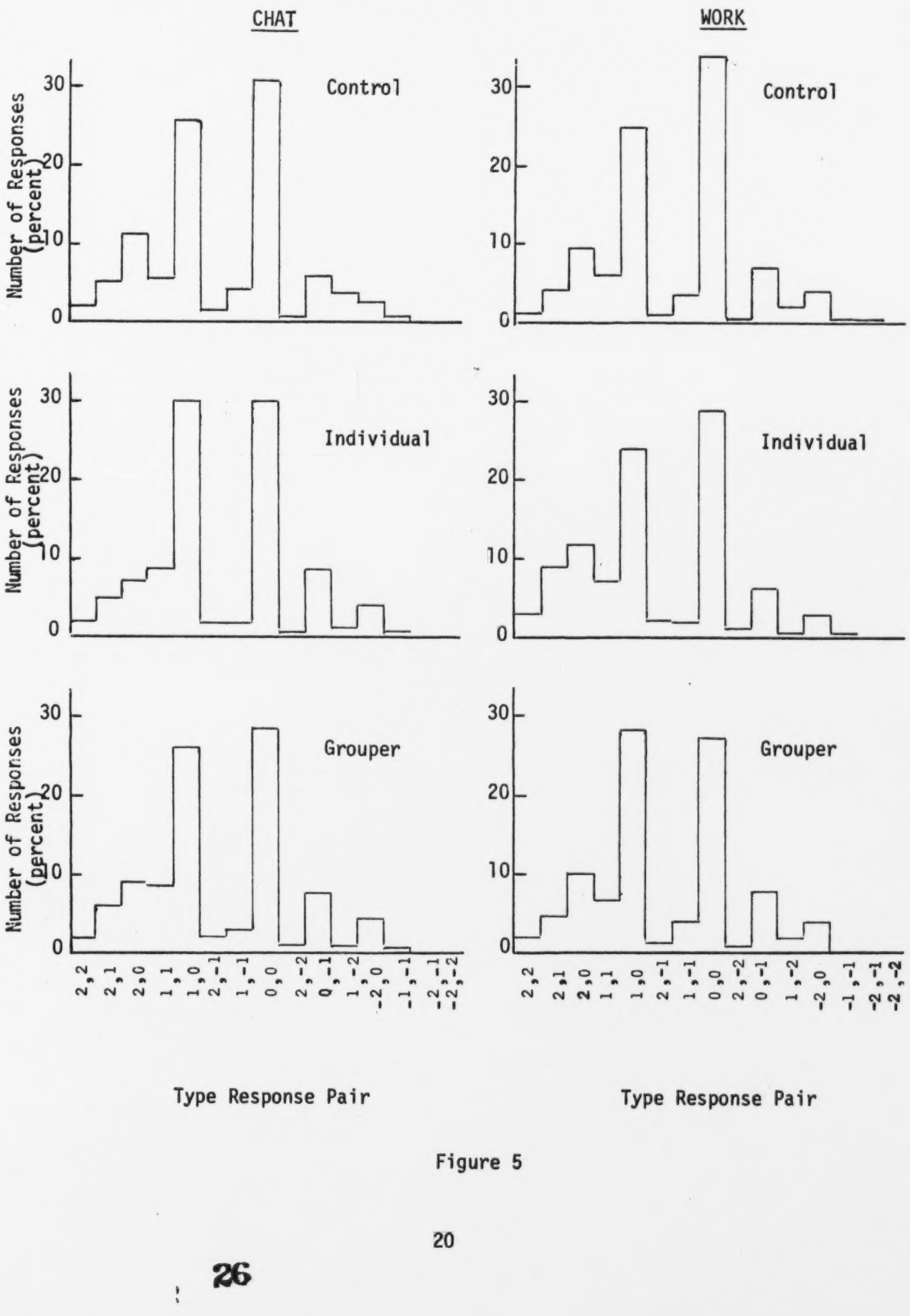
SOCIOMETRIC ANALYSIS
CHAT
WORK
Control
Control
Individual
Individual
Grouper
Grouper
Number of Responses (percent)
Number of Responses (percent)
Number of Responses (percent)
0
10
20
30
2,2
2,1
2,0
1,1
1,0
2,-1
1,-1
0,0
2,-2
0,-1
1,-2
-2,0
-1,-1
-2,-1
-2,-2
Type Response Pair
Type Response Pair

Figure 5

Seventeen, 17, small groups were investigated during the whole experiment, 9 in the Fall and 8 in the Spring. Of the 17, the academic achievement of 6 groups was significantly better than their respective CONTROL subclass. The academic achievement of 4 groups was significantly inferior to their respective CONTROL subclasses.

The sociometric data for these 10 groups for the CHAT portion of the study is shown in TABLES 7 and 8. The last column of these tables, the Gain, is the increase in the average response from the beginning to the end of the semester and should be considered a measure of the improvement in social structure of the small groups. An examination of the changes in the distributions of responses which produce a given value of the Gain suggests that a gain of $\pm.20$ is probably significant. Obviously there is some uncertainty in this number. However, if it is used as a guide line then of the 7 groups whose academic achievement was approximately equivalent to their respective CONTROL subclasses, 6 experienced improved social structure and no significant change occurred in the other.

From this information and the data in Tables 7 and 8 one can conclude the following:

1. Of the academically successful groups, none experienced significant social deterioration and 2/3 of them experienced significant improvement in social structure.

2. The only two groups which experienced significant social deterioration were both academic failures.

3. Improved social structure does not ensure academic success of the group.

In summary, groups which achieve academic success are likely to also experience improved social structure and groups which deteriorate socially are likely to be academic failures.

TABLE 7

SOCIOMETRY OF ACADEMICALLY SUCCESSFUL GROUPS

(Chat Sociogram)

Test Class	Group Number	Survey	No. Students Responding	Frequency of Response Type(%) +2	+1	0	-1	-2	Average Response	Gain
3a	only 1	Final	8	34	43	7	9	7	0.88	0.3
		Initial	9	22	26	44	1	6	0.58	
1b	1	Final	5	75	5	20	0	0	1.55	1.15
		Initial	5	10	25	60	5	0	0.40	
2b	1	Final	7	38	24	38	0	0	1.00	+0.50
		Initial	10	14	27	53	6	0	0.50	
2b	2	Final	5	15	60	20	0	5	0.80	+0.48
		Initial	9	10	39	38	1	12	0.32	
2b	3	Final	5	25	5	65	5	0	0.50	-0.10
		Initial	6	0	67	27	7	0	0.60	
3b	only 1		Hard Data Unavailable						≃0.8	≃0
									≃0.8	

TABLE 8

SOCIOMETRY OF ACADEMICALLY UNSUCCESSFUL GROUPS

(Chat Sociogram)

Test Class	Group Number	Survey	No. Students Responding	Frequency of Responses Type(%) +2	+1	0	-1	-2	Average Response	Gain
1a	4	Final	5	20	20	15	20	25	-0.00	-0.30
		Initial	8	9	16	66	4	5	0.20	
2a	3	Final	6	50	13	30	3	3	1.03	+.26
		Initial	6	20	37	43	0	0	0.77	
1b	3	Final	6	40	37	23	0	0	1.17	+1.47
		Initial	8	28	30	30	4	7	0.70	
2b	4	Final	7	7	31	57	5	0	0.40	-.27
		Initial	7	19	31	48	2	0	0.67	

Chapter IV - CONCLUSIONS

The major results can be summarized in two simple statements:

1. The combination of CAI and group process can indeed produce superior academic achievement.

2. Students prefer both the CAI alone or in combination with the group activity to traditional techniques, with the combination being most preferred.

The combination of CAI and group process does not always produce superior academic results. Some care needs to be exercised in determining group constituency and perhaps the group activities in order to maximize the probability of success of the small groups.

What contribution the CAI makes directly to the success of the small groups is uncertain. Perhaps the computer's greatest contribution to this instructional technique is the records which are maintained and the data analysis which is done by the computer programs. A teacher probably could not converse with and maintain records for more than 8 or 10 groups. This sets an upper limit of about 90 students per teacher if the group activities (which are clearly desirable) are to be used in the teaching process. With the computer a teacher should easily be able to care for 4 or 5 times this number.

The computer assisted instruction of students in small groups is at least as effective as the same CAI materials administered to individuals. Therefore, significant savings (perhaps a factor of 9 or 10) in the cost of implementing and maintaining an effective CAI program can be achieved with the addition of group process.

APPENDIX A

DATA GATHERING INSTRUMENTS

GROUP ESTABLISHMENT

Form A

1. How strongly do you want to participate in this computer assisted instruction experiment?....._____

   (A) I would like to participate very much.
   (B) I would like to participate.
   (C) It doesn't matter to me whether I participate or not.
   (D) I'd rather not participate, but would if asked to.
   (E) I definitely do not want to participate

2. What is your sex? (check one).....male _____;female_____

3. Are you married? (check one).....yes _____; no _____

4. How many semester hours of college math do you have?..... _____

5. What is your age?..... _____

   (A) less than 20 years (B) 20 to 23 years
   (C) 23 to 28 years (D) 29 or older

6. What is your major?....._____

MWF	MONDAY	TTH	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
8		8				
9		9:30				
10						
11		11				
12		12:30				
1						
2		2				
3		3:30				
4						

Name: _____

Address: _____

_____

GROUP ESTABLISHMENT

Form B

1. How strongly do you want to participate in this computer assisted instruction experiment? ....._____

   (A) I would like to participate very much.
   (B) I would like to participate.
   (C) It doesn't matter to me whether I participate or not.
   (D) I'd rather not participate, but would if asked to.
   (E) I definitely do not want to participate.

2. What is your sex? (check one).....male_____; female_____

3. Are you married? (check one) ..... yes_____; no _____

4. How many semester hours of college math do you have? ..... _____

5. What is your age? ..... _____

   (A) less than 20 years (B) 20 to 23 years
   (C) 23 to 28 years (D) 29 or older

6. What is your major? ....._____

7. Who was your instructor in Physics 1341? ....._____

8. I participated in the computer experiment in Physics 1341 last semester and was a member of ....._____

   (A) the "control" subclass (B) the "individual" subclass
   (C) the "group" subclass (D) I wasn't in 1341 last semester

MWF	MONDAY	TTH	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
8		8				
9		9:30				
10						
11		11				
12		12:30				
1						
2		2				
3		3:30				
4						

Name: _____ Address: _____

Phone: _____ _____

Your Code Number _____

Your Lecture Section Number_____

ATTITUDE DETERMINATION

Form A

This information will be held totally confidential. Please be honest!

_____ 1. At the present time, my attitude toward physics as a subject can be described as follows:

A. very interested, like it very much.
B. moderately interested.
C. no particular attitude one way or the other; neutral.
D. moderately disinterested.
E. not interested at all, dislike the subject.

_____ 2. At the present time my attitude toward the professor who is teaching this course can best be described as follows:

A. I like him very much.
B. I like him fairly well.
C. No particular feeling toward him one way or the other; neutral.
D. I have a slight dislike for him.
E. I dislike him very much.

_____ 3. In my previous physics course, my instructor was

A. Professor Massey (Physics 1341) B. Professor Self (Physics 1341)
C. Professor Terrell (Physics 1341) D. Professor Thompson (Physics 1300)
E. Other

_____ 4. I participated in the computer experiment in Physics 1341 last semester and was a member of

A. the "control" subclass
B. the "individual" subclass
C. the "group" subclass
D. I wasn't registered in 1341 last semester.

_____ 5. My semester grade in my previous physics course was _____.

_____ 6. For the experiment this semester, I have been assigned to the

A. "control" subclass B. "individual" subclass
C. "group" subclass

I was assigned to the (check one)

_____"Control" subclass (Non P)

_____"Individual" subclass

_____"Group" subclass

Your Code Number _____

Your Lecture Section Number _____

ATTITUDE DETERMINATION

Form B

This information will be held totally confidential. Please be honest!

_____ 1. As well as I can remember, at the very beginning of this course my attitude toward physics as a subject can best be described as follows (choose one):

A. very interested, like it very much
B. moderately interested.
C. no particular attitude one way or the other; neutral.
D. moderately disinterested..
E. not interested at all, disliked the subject.

_____ 2. At the present time, my attitude toward physics as a subject can be described as follows:

A. very interested, like it very much.
B. moderately interested.
C. no particular attitude one way or the other; neutral.
D. moderately disinterested.
E. not interested at all, dislike the subject.

_____ 3. As well as I can remember, at the very beginning of this course, my attitude toward the professor who is teaching this course can best be described as:

A. I liked him very much.
B. I liked him fairly well.
C. No particular feeling toward him one way or the other; neutral.
D. I had a slight dislike for him.
E. I disliked him very much.

_____ 4. At the present time my attitude toward the professor who is teaching this course can best be described as follows:

A. I like him very much.
B. I like him fairly well.
C. No particular feeling toward him one way or the other; neutral.
D. I have a slight dislike for him.
E. I dislike him very much.

_____ 5. At the beginning of the semester in another questionnaire you were asked how strongly you wanted to participate in the small group experiment. As best you can remember, which of the choices did you choose? The choices which were available were:

A. I would like to participate very much.
B. I would like to participate.
C. It doesn't matter to me whether I participate or not.
D. I'd rather not participate, but would if asked to.
E. I definitely do not want to participate.

SOCIOMETRIC STUDY

We choose to be with different people for a variety of purposes. We may seek one person to work with and another person with whom to just chat about personal experiences and interests.

Consider each of your classmates and how you feel about them. On the following pages you are asked to choose which ones you would prefer to work with, and which ones you would prefer to sit and chat with.

NAME_____DATE_____LECTURE SECTION NO._____

I am a member of the (please check one)

Control group _____; CAI individual study group _____; CAI group study group _____.

WORK

With whom would you choose to work?

Opposite each person's name, enter the appropriate number as follows:

2. If you really would be very pleased to work with this person.
1. If you would like to work with this person.
0. If you don't know how you feel about working with this person.
-1. If you don't particularly want to work with this person.
-2. If you definitely would not like to work with this person.

(An alphabetical list of the names of all students in the class follows)

CHAT (Social)

With whom would you choose to sit and chat?

Opposite each person's name, enter the appropriate number as follows:

2. If you really would be very pleased to socialize with this person.
1. If you would like to socialize with this person.
0. If you don't know how you feel about socializing with this person.
-1. If you don't particularly want to socialize with this person.
-2. If you definitely would not want to socialize with this person.

(An alphabetical list of the names of all students in the class follows)

ROKEACH ATTITUDE SCALE

The following is a study of what the general public thinks and feels about a number of important social and personal questions. The best answer to each statement below is your personal opinion. We have tried to cover many different and opposing points of view; you may find yourself agreeing strongly with some of the statements, disagreeing just as strongly with others, and perhaps uncertain about others; whether you agree or disagree with any statement, you can be sure that many people feel the same as you do.

Mark each statement in the left margin according to how much you agree or disagree with it. Please mark every one.

Write +1, +2, +3, or -1, -2, -3, depending on how you feel in each case.

+1:	I AGREE A LITTLE	-1:	I DISAGREE A LITTLE
+2:	I AGREE ON THE WHOLE	-2:	I DISAGREE ON THE WHOLE
+3:	I AGREE VERY MUCH	-3:	I DISAGREE VERY MUCH

1. The United States and Russian have just about nothing in common.

2. The highest form of government is a democracy and the highest form of democracy is a government run by those who are most intelligent.

3. Even though freedom of speech for all groups is a worthwhile goal, it is unfortunately necessary to restrict the freedom of certain political groups.

4. It is only natural that a person would have a much better acquaintance with ideas he believes in than with ideas he opposes.

5. Man on his own is a helpless and miserable creature.

6. Fundamentally, the world we live in is a pretty lonesome place.

7. Most people just don't give a "damn" for others.

8. I'd like it if I could find someone who would tell me how to solve my personal problems.

9. It is only natural for a person to be rather fearful of the future.

10. There is so much to be done and so little time to do it in.

11. Once I get wound up in a heated discussion I just can't stop.

12. In a discussion I often find it necessary to repeat myself several times to make sure I am being understood.

13. In a heated discussion I generally become so absorbed in what I am going to say that I forget to listen to what the others are saying.

14. It is better to be a dead hero than a live coward.

15. While I don't like to admit this even to myself, my secret ambition is to become a great man, like Einstein, or Beethoven, or Shakespeare.

16. The main thing in life is for a person to want to do something important.

17. If given the chance, I would do something of great benefit to the world.

18. In the history of mankind there have probably been just a handful of really great thinkers.

19. There are a number of people I have come to hate because of the things they stand for.

20. A man who does not believe in some great cause has not really lived.

21. It is only when a person devotes himself to an ideal or cause that life becomes meaningful.

22. Of all the different philosophies which exist in this world there is probably only one which is correct.

23. A person who gets enthusiastic about too many causes is likely to be a pretty "wishy-washy" sort of person.

24. To compromise with our political opponents is dangerous because it usually leads to the betrayal of our own side.

25. When it comes to differences of opinion in religion we must be careful not to compromise with those who believe differently from the way we do.

26. In times like these, a person must be pretty selfish if he considers primarily his own happiness.

27. The worst crime a person could commit is to attack publicly the people who believe in the same thing he does.

28. In times like these it is often necessary to be more on guard against ideas put out by people or groups in one's own camp than by those in the opposing camp.

29. A group which tolerates too much differences of opinion among its own members cannot exist for long.

30. There are two kinds of people in this world: those who are for the truth and those who are against the truth.

31. My blood boils whenever a person stubbornly refuses to admit he's wrong.

32. A person who thinks primarily of his own happiness is beneath contempt.

33. Most of the ideas which get printed nowadays aren't worth the paper they are printed on.

34. In this complicated world of ours the only way we can know what's going on is to rely on leaders or experts who can be trusted.

35. It is often desirable to reserve judgment about what's going on until one has had a chance to hear the opinions of those one respects.

36. In the long run the best way to live is to pick friends and associates whose tastes and beliefs are the same as one's own.

37. The present is all too often full of unhappiness. It is only the future that counts.

38. If a man is to accomplish his mission in life it is sometimes necessary to gamble "all or nothing at all."

39. Unfortunately, a good many people with whom I have discussed important social and moral problems don't really understand what's going on.

40. Most people just don't know what's good for them.

A Student's Evaluation of Computer Assisted Instruction and Small Group Activities

Please give your comments on the value or lack of value of the computer assisted instruction and small group activity experiment that was conducted in Physics 1341 (in the fall semester) and Physics 1342. Comment especially on whether or not it (1) aided your academic performance, (2) increased or decreased your enjoyment of the course and (3) should be continued next year. If you were a member of two of the subclasses (e.g., "non-p" first semester and "individual" this semester) please state so and give comment on each subclass.

I am a member of

_____ The control group (non-p)

_____ Individual group

_____ A small study group called _____

Name _____ Section _____

APPENDIX B

TYPICAL HOMEWORK ASSIGNMENTS AND COMPUTER RESPONSES

1. A 100 kg tackle (apx 220 lbs) while blocking for his quarterback exerts a 350 Newton force on a 70 kilogram defensive halfback. What acceleration will the tackle experience because of the collision?
(A) 35,000m/sec*2, (B) 3.5m/sec*2, (C) 5.0m/sec*2, (D) 24,500m/sec*2
(E) some other value.

2. The box of salt in figure 4 is open and despite the rain, salt pours from the box at a uniform rate. If the box of salt is subjected to a constant force, it will experience an acceleration which
(A) increases... (B) decreases... (C) stays constant...
...as time goes on.

3. Which of the graphs which appear in fig 3 is a correct representation of the relationship between the range of a projectile and the angle from the horizontal at which it is fired?
(A) fig A (B) fig B (C) fig C (D) fig D

4. If there were no air and Matt Dillon fired his pistol vertically upward from ground level, the bullet would go up and then come down and hit the ground with the same speed with which it left the gun barrel. In the presence of air what really happens? The bullet hits the ground with a speed...
(A) higher than... (B) lower than... (C) equal to...
... its original muzzle velocity?

5. If you are a passenger in a car which makes a sharp left turn, you are slammed into the door by a
(A) centrifugal force, (B) centripetal force, (C) gravitational force,
(D) actually none of the above are correct, and it was the door which slammed into you.

6. A colt .45 automatic is held 4 ft. above a level horizontal plane and fired hoizontally. The bullet hits the ground 400 ft. down range. What is the muzzle velocity (actual speed) of the projectile? (Hint: the time of fall is the same as the horizontal travel time.) g=32ft/(sec*2).
(A) 1131 ft/sec (B) 1600 ft/sec (C) 3200 ft/sec
(D) 800 ft/sec (E) 50 ft/sec

7. Matt Dillon must test his colt 45 which Festus has just repaired for him. Matt fires the gun horizontally and just as the bullet leaves the gun, the barrel falls off. Ignoring differences in physical size, which hits the ground first?
(A) the bullet, (B) the barrel, (C) both hit at the same time.

8. A car is at an intersection facing east. In this question, vectors pointing east are considered positive, and vectors pointing west are negative. If the acceleration is positive but the velocity is zero, then the car is
(A) at a stop.
(B) going forward at a constant speed.
(C) going forward with increasing speed.
(D) just starting off from a stop, and going forward.
(E) going forward but slowing down.

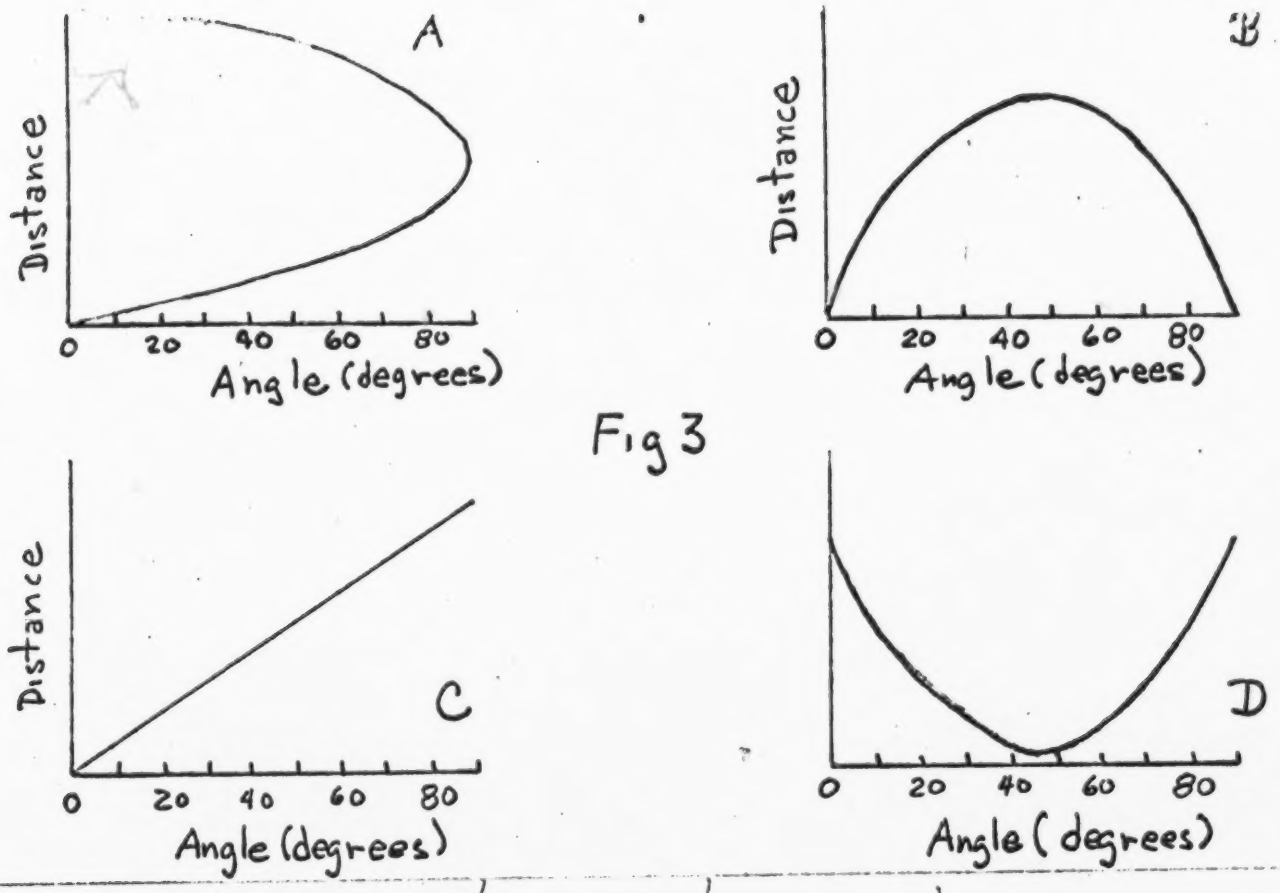

Fig 3

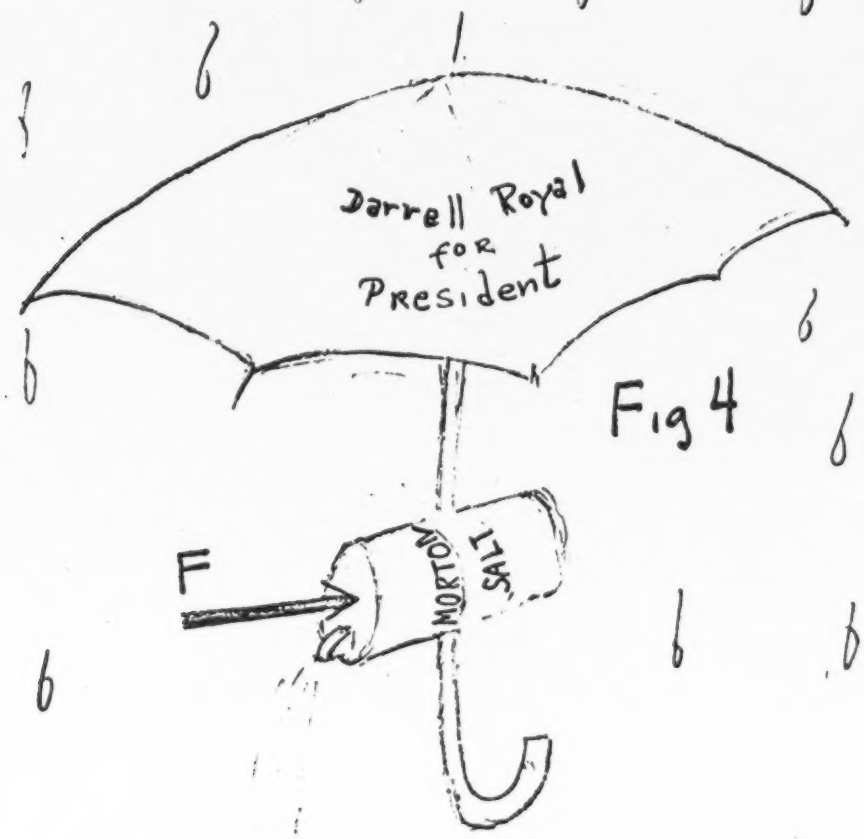

Fig 4

Name _____ Seat # ___ Instructor _____

I am a member of (check one)

__ The control group (NONP)
__ The individual study groups
__ A small study group called: _____

(1 2 3 4 5 6 7 8)

L.

9529

5 4 3 2 1 BOOM!

your answers. b a A b A b c d

1b:
Right! What is the acceleration experienced by the halfback? Another choice?

2 a:
Right! A similar phenomenon occurs with rockets in space. The least sophisticated (but most reliable) rocket engines produce constant thrust (force). As the engine burns, fuel is consumed so that the mass of the rocket decreases with time. Hence the acceleration increases.
Another choice?

3 A:
Wrong! According to the representation you chose, if you fired the rifle at 45 degrees, the bullet would land in two different places. Matt Dillon could kill two varmits with one shot, and even he is not that good. Refer to figure 4.5, Hewitt page 40. If the projectile is fired horizontally at ground level it will hit the ground immediately. If it is fired vertically (90 degrees) it will go straight up and down. Maximum range occurs at 45 degrees. Test this relationship with a garden hose sometime. The correct answer is B. Suppose you plotted range vs muzzle speed. What would the graph look like?
Another choice?

4 b:
Right! Which takes longer, going up or coming down?

5 A:
Wrong! In this case the centrifugal (center fleeing) force is that which you exert against the door. No centrifugal force acts on you. Indeed, one could say that it was the door which banged into you. If not for the door, you would have continued on your way in a straight line with the same speed. Thus no force acted on you until the door collided with you (you should have buckled up). The bump on your head resulted from a force which the door exerted on you; it is the reaction force to the centrifugal force you exerted on it. The correct answer is D. In this case exactly who or what exerted and who or what experienced a centripetal force?
Another choice?

6 d:
Right! In what other ways could you determine the muzzle velocity?
Another choice?

7 c:
Right! Since the earth is curved, which one really hits first?
Another choice?

8 d:
Right! What if the velocity were positive and the acceleration were negative?
Another choice?

Jack A. finished at 3 30 50 on 06/27/72
Today. 75.00

Adjusted. 83.64

You used. 3 minutes and 4 seconds.
The average is. 5 49

please remember to "save then "off.

APPENDIX C

WRITTEN INSTRUCTIONS TO STUDENTS

AS AN INDIVIDUAL

TO OBTAIN THE COMPUTER OUTPUT

1. a. Turn terminal power on.
   b. Move "remove-local" switch to "remote"
   c. Determine that coupler switch is in "off" position.

2. Lift phone receiver and dial 691-5151.
   The computer will answer with a high pitched tone.
   Then place receiver in the coupler pad, and close the acoustical box, and turn the coupler "on".
   (If the computer is "busy" hang up and dial again. If you don't get through to the computer in a minute or two, please see Drs. Self or Terrell.)

3. Type (including the quote symbol) "]75200]
   AND FOLLOW IT BY PUSHING THE RETURN KEY!
   (Everything you enter into the computer must be followed by a RETURN before the computer can begin considering it.)
   The computer will respond with the time of day and date, then a p 1? 360

4. Type (including the " symbol) "load _____ (remember to RETURN.)
   (1 space)

5. The computer will respond again and stop after it types "L:" at the left margin. If the computer behaves otherwise, please leave it exactly as is, and fetch Drs. Terrell or Self.

6. Type your i.d. number (last 4 digits of your social security number)
   _____(RETURN!)
   You are now in communication with the computer program which has been prepared especially for you.

7. In response to the computers question "other choices?" you must type (a b c d e) and/or "return".

8. When the output is finished (these operations and the order of execution are very important).
   a. type (including the "symbol) "save The computer will respond with some numbers and _____.
   b. then type (including the "symbol) "off The computer will respond once again and then the computer breaks the communications link with the terminal.

9. In order to turn the terminal off, execute the following in the order listed.
   a. Turn the coupler off.
   b. Hang up the phone.
   c. Turn the terminal power off.

Thank you.

SPECIAL NOTE: If another student has shown up by the time you finish getting your output and he is ready to receive his output, he may be spared the trouble of dialing the computer, etc. if you do not sign off. As soon as you have executed the "save command, he may begin his conversation with the computer starting with step 4 (the point where he types "load _____). Your consideration in this matter can save everyone a lot of time, and it will be especially appreciated when a computer breakdown causes a log jam in our timing schedule.

GROUP MEETING

A member of the group should act as group leader at each group meeting. This "leadership role" should be rotated among the group membership until every member has had at least one turn. You may then select a "permanent" group leader if you like. The "group leader" has two responsibilities:

1) Moderate the group discussions, and

2) See that the agenda (including item 1) is accomplished.

AGENDA

1) Spend no less than 10 minutes visiting (socializing).
2) Wear name tags for at least the first 2 meetings.
3) When you begin discussing the questions, discuss them one at a time in the order in which they appeared on the homework assignment.

IMPORTANT: Be certain that <u>every</u> group member contributes something on <u>every</u> question before the group's answer is determined.

- - - -

The tone of the meeting should be respect for each others feelings. The goal of your group effort is "understanding why, as well as knowing what the right answer is." Get to the point of understanding!!!

In no case should a group meeting last fewer than 30 minutes or longer than 50 minutes.

AS A GROUP

TO OBTAIN THE COMPUTER OUTPUT

1. a. Turn terminal power on.
   b. Move "remove-local" switch to "remote"
   c. Determine that coupler switch is in "off" position.

2. Lift phone receiver and dial 691-5151.
   The computer will answer with a high pitched tone.
   Then place receiver in the coupler pad, and close the acoustical box, and turn the coupler "on".
   (If the computer is "busy" hang up and dial again. If you don't get through to the computer in a minute or two, please see Drs. Self or Terrell.)

3. Type (including the quote symbol) "]752000]
   AND FOLLOW IT BY PUSHING THE RETURN KEY!
   (Everything you enter into the computer must be followed by a RETURN before the computer can begin considering it.)
   The computer will respond with the time of day and date, the a p 1? 360

4. Type (including the " symbol) "load _____ (remember to RETURN.)
   space

5. The computer will respond again and stop after it types "L:" at the left margin. If the computer behaves otherwise, please leave it exactly as is, and fetch Drs. Terrell or Self.

6. Type your group name, exactly like this _____ (RETURN)
   You are now in communication with the computer program which has been prepared especially for you.

   a. The computer will check roll by asking you to put an a (for absent) or p (for present) under the name of each group member. (RETURN)
      (The spaces between the a's and p's are not important)

   b. The computer then asks you to type in the groups answers. (RETURN)

7. In response to the computers questions "other choices?" you must type (a b c d e) and/or "return".

8. When the output is finished (these operations and the order of execution are very important).

   a. type (including the "symbol)"save The computer will respond with some numbers and _____.
   b. then type (including the "symbol) "off The computer will respond once again and then the computer breaks the communications link with the terminal.

9. In order to turn the terminal off, execute the following in the order listed.

   a. Turn the coupler off.
   b. Hang up the phone.
   c. Turn the terminal power off.

Thank you.